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Visual Feedback for Skill Acquisition in Cataract Surgery

Advanced Computer Integrated Surgery

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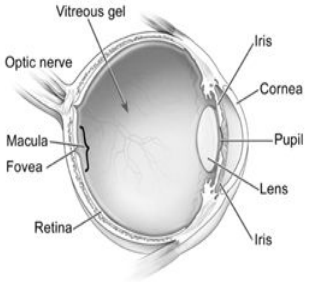
02/28/2017

Mentors: Austin Reiter; Swaroop Vedula

Background and motivation

Cataract is clouding of the lens in the eye which in turn affects vision. It is pretty common in older ages.



https://nei.nih.gov/health/cataract/cataract

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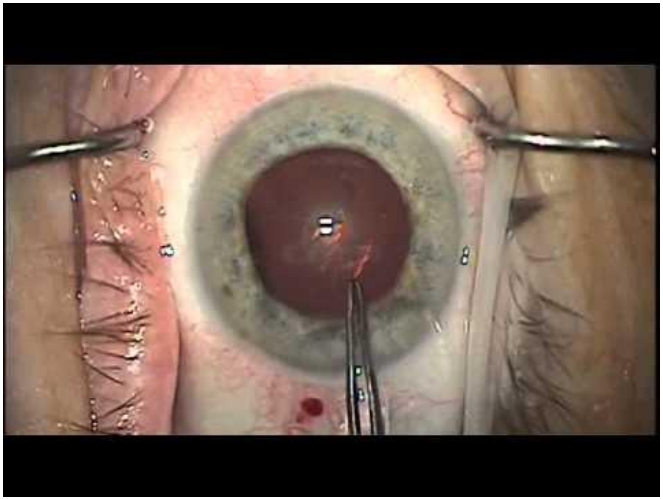
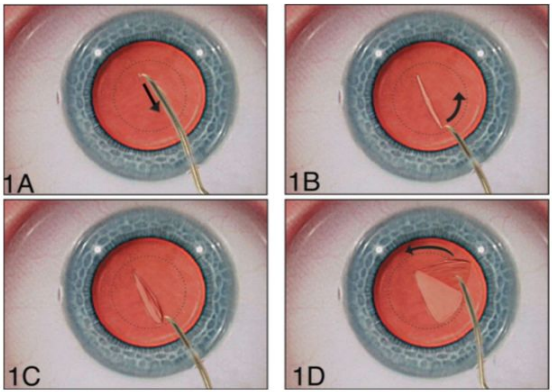
Capsulorhexis



Background and Motivation

- Technique by Howard Gimbel to remove the lens capsule during cataract surge
- Use the same bent needle to begin a tear in the capsule
- Use forceps or needle to remove the lens

The surgical task: Capsulorhexis



http://m3.wyanokecdn.com/93bc0e0140cbe5d90fef89d85b876887.jpg

Motivation and Background

- Not high risk, sometimes can cause run away tears
- Leakage of vitreous humor
- Skill required to mend tear - **high!**
- Current Feedback for skill acquisition is verbal instruction
- Better to have directed feedback
- **Aim** - Develop visual feedback to support skill training during task performance

Da Vinci Research Kit

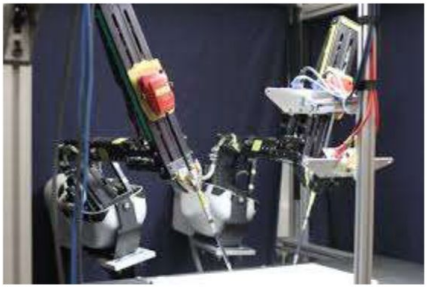
"open-source mechatronics" system, consisting of electronics, firmware, and software that is being used to control research systems based on the first-generation da Vinci system.

More information :

https://github.com/jhu-dvrk/sawIntuitiveResearchKit/wiki

http://research.intusurg.com/dvrkwiki/index.php?title=Main_Page

The robot (data source): *da Vinci* Research Kit



http://cal-mr.berkeley.edu/images/media/DVRK-2-high-res.jpg

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Technical overview brief steps

- Operate the dvrk on phantom
- Collect video of the operation
- Collect tool force data using a ROS node from the da vinci research kit
- Determine tool force at each co-ordinate of each frame of the video
- Use regression techniques to determine tool force and direction at any co-ordinate of the image

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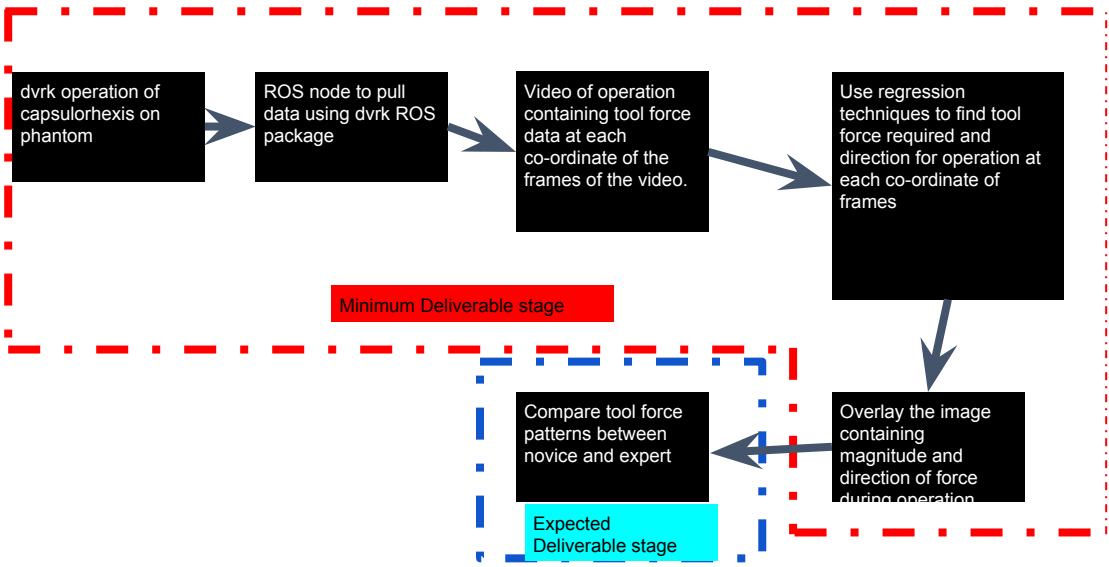
Brief workflow



Deliverables

Minimum:

- Simple phantom to simulate the task
- Video of tool motion with da vinci research kit
- Visual overlay of tool forces

Expected:

- Compare tool force pattern between experts and novices

Maximum:

- Data of errors in this estimation

Dependencies

Dependencies	**State (resolved/pending/in progress)**
Phantom for simulation of the task	In progress
Setup of Da Vinci research Kit ROS package	In progress
Access to Da Vinci Research KIT	In progress (have talked with Anton)
Software setup (misc. i.e script for supervised learning, ROS node for pulling data from dvrk, visual overlay system, relevant OpenCV packages)	Pending
Force sensor	In contact with Preetham
Experts for operation	Pending
Mentors	Resolved
Regression Technique	Yet to be decided

This could go wrong!!

- Data obtained is insufficient - probably use different sensors, keep occlusion in mind, collect more data
- Cannot obtain experts - try to validate with existing people

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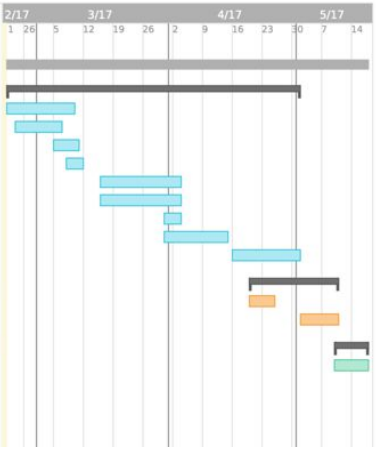
Time-Line

CIS 2	start	end
Minimum deliverables	**02/22/17**	**05/01/17**
Simple phantom to simulate the task	02/22	03/09
Understand DVRK software	02/24	03/06
Understand how to use DVRK	03/05	03/10
Setup ROS node to pull data from dvrk	03/08	03/11
Operate on the phantom using the dvrk to collect data	03/16	04/03
Video of tool motion with dvrk	03/16	04/03
Extract Tool-force vector at each co-ordinate in each frame of video	03/31	04/03
Estimate tool-force vector for any point of the procedure	03/31	04/14
Visual overlay of tool force vectors	04/16	05/01
Expected Deliverables	**04/20/17**	**05/10/17**
Obtain video data of operation via experts and novices	04/20	04/25
Compare the tool-force patterns between experts and novices	05/02	05/10
Maximum Deliverable	**05/10/17**	**05/17/17**
Compute errors in tool-forces between estimated and actual	05/10	05/17



Members

Group members: Abhilash

Mentors: Austin Reiter; Swaroop Vedula

Weekly meetings: On demand

Reading List

[1] Lam, Chee Kiang, et al. "Virtual phacoemulsification surgical simulation using visual guidance and performance parameters as a feasible proficiency assessment tool." BMC ophthalmology 16.1 (2016): 88.

[2] Reiley, Carol E., et al. "Effects of visual force feedback on robot-assisted surgical task performance." The Journal of thoracic and cardiovascular surgery 135.1 (2008): 196-202.

[3] Kazanzides, Peter, et al. "An open-source research kit for the da Vinci® Surgical System." Robotics and Automation (ICRA), 2014 IEEE International Conference on. IEEE, 2014.

[4] Gerovich, Oleg, Panadda Marayong, and Allison M. Okamura. "The effect of visual and haptic feedback on computer-assisted needle insertion." Computer Aided Surgery 9.6 (2004): 243-249.